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Book Review

Geofluids (2009) ***9****, 75–76* **Tectonic Faults – Agents of Change on a Dynamic Earth** *Handy, M.R., Hirth, G. and Hovius, N., (eds), 2007. Report of the 95th Dahlem Workshop on the Dynamics of Fault Zones, Berlin, 16–21 January 2005. The MIT Press, 446 pp.*

This book is a product of the 95th Dahlem Workshop, which brought together 41 scientists engaged in various aspects of basic and applied research on fault zones.

The Dahlem Workshops (Dahlem Konferenzen) employ a structured format for scientific dialogue and interaction. Selected workshop participants provide background papers that are the basis for discussion by four interdisciplinary working groups. Such background papers constitute most of the Dahlem proceedings (nine chapters in this instance). During the workshop, each working group prepares a report summarizing its discussions. These four reports, and an introduction, comprise the book's remaining chapters. All participants are encouraged to revise their papers in the light of discussions during and after the workshop and on the basis of peer-review comments.

The effectiveness of this approach may be judged by the success of the two to three annual Dahlem Konferenzen on diverse topics and the fact that the resulting reports are often authoritative and influential. A classic example is the report of the Eighth Dahlem Konferenzen, *Global Geochemical Cycles and their Alteration by Man* (Stumm, 1977), which spurred awareness of anthropogenic impacts on global carbon cycles. The Dahlem Konferenzen are named after the Berlin district of Dahlem, which hosts several Max Planck Institutes, the Wissenschaftskolleg, and the Freie Universitat Berlin. Since 1990 the Dahlem Konferenzen have been part of the Freie Universitat Berlin, which covers the basic costs of the workshops.

This particular Dahlem Konferenzen was motivated by faults 'as primary agents of change at the Earth's surface' in the light of their roles in channeling fluid flow within the lithosphere, thereby linking asthenosphere with biosphere and atmosphere. Faults are sites of enhanced dissolution and precipitation, localizing mineral deposits; create topography; and provide pathways for molten rock.

The four workshop themes were:

(1) nucleation and growth of fault systems (Kevin Furlong, rapporteur);
(2) rheology of fault rocks and their surroundings (Terry Tullis, rapporteur);
(3) surface environmental effects on and of faulting (W. Roger Buck, rapporteur) and
(4) fluids, geochemical cycles, and mass transport in fault zones (Mark Person, rapporteur).

From the perspective of *Geofluids*, an interesting aspect of this book is that virtually every chapter recognizes the importance of aqueous fluids. Even a chapter with the unpromising title of 'Fault zones from top to bottom – A geophysical perspective' (Walter Mooney *et al.*) emphasizes the role of water–rock interaction in the temporal evolution of seismic velocity structure. Other chapters focus directly on the role of fluids, for instance 'Fluid processes in deep crustal fault zones' (Bruce Yardley and Lukas Baumgartner), 'Deformation in the presence of fluids and mineral reactions…' (Jean-Pierre Gratier and Frederic Gueydan) and 'Fluids, geochemical cycles, and mass transport in fault zones' (a group report by Mark Person *et al.*). Throughout the book, there is extensive discussion of the evidence for deep aqueous fluids, their influence on the physical and chemical properties of rock, and their effects on the ambient physical conditions of fault movement, healing and sealing.

Clearly, awareness of 'geofluids' has permeated the fault-zone research community. In fact, fully one-third of the 41 workshop participants list fluid-related topics among their personal research interests, citing topics such as fluid flow in deformable media, fluid–rock (geochemical) interaction, hydrothermal modeling and fluvial geomorphology (pp. ix–xiii). And those who do not explicitly cite a research interest in fluids include recognized experts on fluid–rock interaction such as poroelasticity authority Jim Rice.

Some of the least familiar and most interesting material, from my own perspective, dealt with strain localization and with the interaction between surface processes and mechanical stability of rocks at depth. My interest in the former topic is no doubt colored by the fact that our family home is less than 100 m from the San Andreas Fault. For reasons that appear to remain somewhat mysterious, most displacement in successive ruptures may be localized within a core zone a few centimeters thick, despite the fact that the width of the damage zone for major strike-slip faults may be hundreds of meters or more. I hope that this will continue to be the case in our backyard. A full set of chapters on surface process effects emphasizes the positive feedback between surface mass flux (erosion) and uplift (chapters 8–10 by Peter Koons and Eric Kirby, Niels Hovius and Friedhelm van Blanckenburg, and Roger Buck *et al.*). Elevated topography and denudation rates can actually influence the location and rates of interplate deformation. This mechanical link between surficial and deep crustal processes is perhaps not surprising in the light of accumulating evidence for links between the surface hydrologic cycle and earthquake frequency, but is nonetheless fascinating.

Because this volume resulted from a late 2005 conference, it may seem dated in some respects to workers who are intimately engaged in this area of research. But to relative outsiders like me, it provides a useful and fairly complete overview of then-current thinking – the vast majority of which is presumably still valid. The quality of writing/editing is consistently excellent and the figures are clear, although some chapters are sparsely illustrated. At US $45 the price is reasonable.

The book shows evidence of considerable interaction among the many authors and editors, including extensive cross-referencing and a unified, 18-page index. The Dahlem Konferenzen format essentially guarantees such an interaction. However, there is no attempt to present a completely coherent worldview. Differences in opinion within the community are evident from close reading of the various chapters. To cite one example, Walter Mooney *et al.* accept the view that temperature is the dominant parameter controlling the brittle–ductile transition (chapter 2, p. 17), whereas Bruce Yardley and Lukas Baumgartner argue convincingly for the controlling influence of free fluid (its presence or absence) on the location of the brittle–ductile transition and on crustal rheology in general (chapter 11, pp. 308–310). This lack of absolute consistency reflects the Dahlem Konferenzen philosophy, which is not necessary to reach consensus, but to identify gaps in knowledge, including contentious points, and suggest directions for future research. All chapters provide some overview of unresolved issues, and many list rather specific unresolved questions. For instance, the working group report on 'Fluids, geochemical cycles, and mass transport…' concludes with a list of questions such as 'Where do fluids in fault zones originate and at what rate are they available to fault zones?' (chapter 14, p. 422).

As an outsider, it is difficult for me to evaluate the extent to which this particular Dahlem Konferenzen provided novel insights. However, it was clearly successful in bringing together diverse points of view that do not normally need to be reconciled because they come from different subdisciplines.

The participants' broad recommendations for future research included:

Studies focused on natural laboratories and interacting processes. Natural laboratories discussed by workshop participants included the European Alps, the Southern Alps of New Zealand, the Aegean trench-backarc system, the North Anatolian and San Andreas faults, the Cordilleran orogens, and the Himalayan–Tibetan orogen-plateau system. The participants emphasized the importance of prolonged campaigns to collect and interpret large, diverse data sets.

Experimental laboratory studies, particularly experiments pertaining to fault weakening and the role of fluids and gels. There is a need for new laboratory apparatus that can better approach natural conditions.

Improved data acquisition and processing, particularly with respect to seismic-imaging and surface-dating methods.

Modeling to test hypotheses and make predictions, including both physical modeling using Earth-like materials and numerical/analytical models. In this regard the participants noted, for instance, the potential of high-powered computing to test theoretical concepts on the nucleation and growth of slip surfaces, and the adaptation of climate-change models to explore long-term effects of faulting and weathering on carbon budgets.

Quite logically, given the societal motivations for this area of research, the participants gave roughly equal weight to *outreach* under the heading 'Recommendations for future research'. Their emphasis reflects the duty of scientists to better prepare the public for catastrophic events and to educate cognizant officials about the risks associated with active faulting.

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